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Forty persons attended this workshop, designed to identify consultants and orient them to the needs of community colleges and technical institutes when developing, revising or upgrading mechanical technology programs. Presentations by some of the nation's leading technical educators were followed by discussion periods and critique, both of which are included in thi s pamphlet. The publication is intended as a guide to consultants and as an introduction for Junior College administrators formulating programs in technologies related to mechanical engineering. Papers presented discussed: (1) the advantages of using consultants and initial arrangements for their use by K. Skaggs, (2) background data and information on technician supply and demand, and issues and concerns relevant to consultant service, by S. Brodsky, (3) steps for developing curriculum for mechanical engineering technologies by S. Peterson, (4) basic teaching methods and materials by R. Michael, and (5) facilities and staffing for mechanical engineering technologies by H. Cunningham. (FP)

CONSULTANTS WORKSHOP ON

Proceedings of a Consultants Workshop on

TECHNOLOGIES RELATED TO MECHANICAL ENGINEERING

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PREFACE

The Occupational Education Project (OEP) of the American Association of Junior Colleges has as a major objective the development in American junior colleges of occupational education programs. These would serve the manpower needs of local regions and of the nation as a whole, and be congruent with the needs, abilities, and aspirations of students in the junior colleges. One facet in the accomplishment of this objective is to make available to junior colleges and to other institutions a corps of qualified consultants to assist in program development. A previous activity in this area was in the field of civil engineering technology.

To identify such consultants in the field of mechanical engineering technology and to orient them to recent developments and to their responsibilities, a consultants workshop was held in San Antonio, Texas, in May 1968. Approximately forty leaders in this field met for two and a half days and held extensive discussions.

Aaron J. Miller, coordinator for development and training, The Center for Vocational and Technical Education, The Ohio State University, participated in the meeting as a discussion leader and has undertaken in this publication to edit the proceedings. He is particularly well qualified for this assignment, both because of his participation in the San Antonio workshop and because of his extensive background and experience in many areas of occupational education.

The publication is intended both as a guide to consultants who will be engaged in these activities and as an introduction to technologies related to mechanical engineering for junior college administrators formulating programs in this field.

The OEP office will gladly furnish to interested parties the names of qualified consultants.

The activities of the OEP are supported by a grant to the Association from the W. K. Kellogg Foundation in Battle Creek, Michigan.

LEWIS R. FIBEL
Specialist in Occupational
Education, AAJC

INTRODUCTION

With the great expansion of technician education programs related to mechanical engineering, community colleges and technical institutes frequently need assistance in developing new mechanical technology programs and in revising and upgrading existing ones. This assistance may frequently be supplied by a qualified consultant.

The American Association of Junior Colleges, through the Occupational Education Project, assisted in meeting this need for qualified consultants by sponsoring a consultants workshop for technologies related to mechanical engineering.

In this workshop, insightful and provocative papers were presented by some of the nation's leading technical educators. These papers addressed themselves to topic areas in which a consultant in mechanical engineering technology might be called upon to provide advice. These presentations were followed by further discussion and critique by other leading educators and consultants in technologies related to mechanical engineering. These proceedings attempt to capture those presentations and the discussion and critique sessions which followed.

It is hoped that this document will provide a general guide for both those who may serve in a consultative capacity and those who anticipate utilizing the services of a consultant.

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ON BEING A CONSULTANT

by KENNETH G. SKAGGS *

The consultant is a person who, by virtue of his past experience, his knowledge of his own field of specialization, and his contributions to the educational area which he represents, is able to help others in planning, developing, and implementing programs in problem solving, in identification of issues and concerns, and in developing sound working relationships and procedures. The value of the consultant is not that he is more knowledgeable or more experienced than those already on the campus — frequently he is not — but that he comes to the college objectively and freshly alert, not influenced by the personalities, familiarities, backgrounds, or conventions of the campus.

Consultants may be employed for a wide variety of purposes and reasons, but in terms of the primary objective — program development — the following are the major reasons for requiring outside consultative assistance:

Specialized knowledge and skills: When facts or information concerning a highly sophisticated and technical field are not known to members of the staff, a college may seek the assistance of a specialist to help in planning feasibility surveys, or developing a new curriculum or program.

Time and manpower savings: Problems are known to have been faced and successfully resolved elsewhere; hence a consultant may be brought in to point out the ways to resolve a similar task expeditiously. In addition, the need to organize a new program, or modify existing programs may not permit the expenditure of endless time and manpower to get at the solutions to the problems. Even when qualified college personnel are available, time schedules and other responsibilities may keep them from adequately attending to the details of a new task.

Objectivity and a fresh viewpoint: Another reason for seeking consultative assistance is the need to obtain the viewpoint of an outsider. The facts are available, the problem stands out in bold relief, several solutions to it are apparent, but agreement cannot be reached on a solution acceptable to all concerned. An outside consultant, presumably free of bias, may be brought in to introduce a fresh approach which had not previously been considered.

Extension of resources: An outside consultant, by virtue of his position, may have more resources than do local talents. Often what is needed is not

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assistance in solving issues relating to program development, but knowledge and suggestions on where to find money, personnel, facilities, or materials with which to begin the development of a new program.

The college's ultimate choice of a consultant is contingent upon the particular function he is expected to serve. Since consultants generally do not think of themselves in terms of "time-manpower savers," or "firefighters," it is incumbent upon the consultant seeker to carefully determine the function which the consultant is to serve.

A consultant may serve as:

ADVISER: To counsel in time of need

ARBITRATOR: To mediate differences of opinion between opposing factions

DECORATOR: To enhance the image and prestige of the institution

DISPENSER: To provide specialized information and expertise

EVALUATOR: To assess the strengths and weaknesses of the institution

FIRE-FIGHTER: To resolve a problem or settle a crisis with great dispatch because no alternative is available

INNOVATOR: To introduce new ideas, concepts, methodologies, or approaches.

It is difficult to suggest criteria by which potential consultants' qualifications may be judged, since the nature of the colleges' consultative purposes and their general contexts may differ widely. Perhaps the most useful investigation of qualifications would be obtained through brief preliminary discussions with the tentatively selected consultants themselves. Whether the evaluation is determined through such discussions with the consultant candidates or through references from other agencies, the relevancy of qualifications sought should center about the particular purpose to be served.

Desirable personal characteristics of consultants include:

OBJECTIVITY: Approaches problems without preconceived ideas as to their solution

INDEPENDENCE: Is not influenced by status of personnel or by vehement objections to suggestions, has courage of his convictions

INTEGRITY: Respects confidences

PATIENCE: Works patiently on assignments which call for long hours of discussion, or which require attention to masses of detail

TACT: Has ability to deal with people gently but firmly

RAPPORT: Maintains harmonious relations with college personnel.

Following the selection of the consultant whose qualifications appear appropriate for the purpose to be served, the college should then write a letter of invitation and appointment. The letter should: (1) state specifically the purpose of the assignment; (2) state the conditions of his engagement: time to be spent, place, date, reports, remuneration, etc.

Three kinds of preparation are involved in preparing for the consultant's visit: preparation of the consultant, preparation of staff at the college, and preparation of a schedule for the consultant's visit.

1. Keeping the purpose of the consultation in mind, send to the consultant carefully selected and pertinent materials that will be helpful to him in preparing for the visit. If tangible items are not available, the consultant should be so informed. Again, the purpose of the visit will determine the kinds of background information the consultant should have.
2. Make certain that staff and personnel concerned with the visit are apprised that the consultant has been selected.
3. Confer with staff members concerned with the consultant's visit and plan a schedule (allowing sufficient time for each step, conference, or interview). Again, the nature of the consultation will determine the extent of preparation required. If facilities and activities are to be observed or evaluated, the schedule should make allowances for this as well as for discussions. The schedule should allow for flexibility to make possible revisions, if need be.

Prior to the consultant's visit, arrange for: suitable hotel accommodations, convenient transportation, meals, and an appropriate welcome.

During his visit, provide: adequate conference space, office supplies, secretarial or clerical help, a guide or escort, faculty schedules, directory to particular facilities and offices, adequate time for introductions to faculty and administrative personnel concerned with visit, a list of advisory board members, with freedom to contact them, and any additional information helpful to the consultant.

General considerations are as follows: avoid excessive socializing or commitment to social obligations which may lead to bias; allow consultant time to reflect on visit and prepare preliminary report; check with consultant periodically to ascertain specific needs or requests; do not leave consultant "hanging" at end of the day — make necessary arrangements for evening; reaffirm following day's schedule; and provide for intracollege communication.

Depending upon the nature of the consulting task, all who are concerned should be prepared to meet the consultant to review the purpose and planned schedule for the visit. If known at this time, the consultant should be informed of the kind of report or presentation expected of him at the conclusion of his undertaking. In addition to knowing what is expected of him, it would not be amiss to discuss and clarify what is not expected of him. Such an understanding would safeguard against the college expanding the limits of the agreed upon assignment, and will ensure that the consultant will not overstep the bounds of his assignment or infringe upon work to be done by others.

Facilities, and secretarial or clerical assistance should be put at the consultant's disposal, particularly if a report is expected of him before he concludes his visit. In any event, opportunity — time and space — should be provided for the consultant to summarize the events of the visit.

At the conclusion of the visit, plan a conference with the consultant and key individuals to discuss findings and recommendations.

There are several expectations of the consultant himself — in other words, when one is invited to a campus to do a professional job of advising and consulting, the consultant expects that certain preparations will be made for him and that certain courtesies will be observed by the institution. Briefly these are: arrangements for housing and food; mutual discussion of procedures, schedules, etc.; a "place to work"; a minimum of social obligations; some freedom; total honesty; and prompt payment of fees and expenses.

Depending upon the nature and purpose of the consultation assignment, the consultant may or may not have completed his responsibilities at the conclusion of his visit to the college. If a report is part of his job by prior agreement, the consultant should prepare and complete it with dispatch. Promptness in submitting reports enables the college to plan and implement its next steps.

DISCUSSION BY PARTICIPANTS

A consulting situation sometimes arises where the consultant is called upon to assist the institution in determining overall program goals based upon the institution's stated philosophy, institutional needs, community needs, and resources. Once these program goals have been determined, an appropriate curriculum can then be structured. However, a consultant has a difficult assignment where goals must first be determined before curriculum decisions can be made. If an institution's program goals and expectations are clearly stated, the framing of curriculum recommendations is somewhat easier.

Before accepting a job, the consultant must carefully analyze his own competence, the expectations of the employing institution, his personal objectivity, and then make a professional decision concerning the acceptance of the job. Once the job is accepted, the consultant should insist upon all possible data and information concerning the job prior to his visiting the site. If the job calls for expertise beyond that of the consultant, he should refuse the job.

As a part of most consulting jobs, a final report is expected. The consultant should remember that a final report is not only critical of areas and programs where improvements need to be made, but also points out good features of existing programs and is positive and reinforcing whenever possible.

It is established that in almost all formal consulting situations, a consultant is entitled to a fee for his professional services. It should be pointed out, however, that most consulting jobs are informal in nature, taking place in a friendly atmosphere, where the advice of the consultant is given free of charge.

While many requests come to a consultant in writing, requests are frequently made by telephone. If the consultant responds to a telephone request, he should ask that a formal request for his services be clearly stated in writing; and he in turn should accept the position in writing. At the outset the consultant should outline what he views his consulting role to be and what he proposes to do on the job.

An important step of a consulting job is to determine if the goals, objectives, and expectations of the program are clearly stated. If, for some reason, this has not been done, the consultant can serve a valuable purpose in assisting the institution in clarifying its goals and objectives for the program.

The "hidden time" demands upon a consultant should be recognized. If a consultant is to fulfill his role properly he must be well prepared before visiting the site. After the time spent at the site, there are final reports to write and perhaps other expectations of the consultant. It should therefore be recognized that if a consultant spends several days at a site on a consulting job, it will normally take that much more time in terms of initial preparation and final job completion. As a consultant is frequently paid only for the time he is at the visitation site, this fact should be taken into consideration when the consultant sets his fee.

Occasionally requests for a consultant will be made where a purpose is stated for the consultant's visit, but when the consultant arrives he may find some other "hidden problem or agenda." While it is virtually impossible to detect the hidden agenda, the consultant should be aware that the hidden or unstated problem frequently exists and he should be prepared to react accordingly. To help clarify the purpose of the consultation and avoid misunderstandings, the consultant should request that the staff of the institution be informed of the purpose of his visit.

Where the consultant is employed full-time as a professional in another institution, he should be sensitive to the time demands placed upon him by accepting consultant jobs. Where an outside consultant job seriously interferes with or hampers his performance in his full-time employment, the consultant job should be refused.

In the consultant's role, the consultant should never allow himself to be used as a "rubber stamp" to approve some program, project, or set of guidelines for the sole purpose of justifying some previous administrative decision. The consultant should accept a job only where a legitimate job exists. This assignment should be accepted with the understanding that the consultant will be expected to be completely honest and forthright in assessing the quality of the program.

It is frequently suggested that a consultant should not accept employment in his immediate geographical area. However, this depends to a great degree upon the professional competence and reputation of the consultant. Only a small percentage of institutions ever engage the services of a consultant, while many institutions could occasionally benefit from the services of a consultant in arriving at a solution to some pressing problem. This is in part due to the fact that many institutions do not understand how to use a consultant properly. Therefore, it would be entirely appropriate for some professional organization to consider the publication of a brochure or booklet which clearly outlines how a consultant might best be utilized by an agency or institution.*

* Editor's note: A booklet of this nature has been published by the American Association of Junior Colleges, *On Using and Being a Consultant*, price $1.

THE NEED FOR TECHNICIANS IN FIELDS RELATED TO MECHANICAL ENGINEERING

by

STANLEY M. BRODSKY*

The initial purpose of this paper is to provide background data and information on technician supply and demand. While many may be familiar with most of this data, there may be some information to provide new insights for the reader.

Such investigations become relevant to the consulting process in several ways. Proposals for initiating curriculums usually require a needs justification in terms of output. A consultant may be asked to review and interpret local proposals, to suggest additional sources of information, or to conduct or plan a needs study. Consultants charged with evaluating or guiding institutional self-study of existing curriculums may determine that verification of assumed needs or identification of important employment trends are necessary to the evaluative process.

In one way or another, justification for an occupational curriculum rests primarily on output needs; and, if that criterion is met, on a host of other factors including input needs, institutional commitment, staff availability and capability, space and equipment allocations, capital and operating expenses, and industrial and governmental cooperation.

Ground Rules

As technical educators, we have allowed sloppiness to develop in our terminology relating to technical occupations because of the diversities of levels of vocational and technical education, and the natural usage of unwarranted labels to satisfy the pressures of status and academic dignity. Each of us has had the disconcerting experience of thinking we were comparing notes on mechanical technology students with a visiting colleague only to find that the other party was responding in terms of pre-engineering students. Therefore, for the purposes of this discussion, the following assumptions are made:

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1. This discussion pertains to curriculums at the associate degree level which produce technicians for fields related to mechanical engineering.

2. Such curriculums require at least the equivalent of two years of full-time, on-campus study, but no more than three years, exclusive of remediation, removal of admission conditions, or preliminary pretech programs.

3. Within the framework of the two previous assumptions, the curriculums included may be intended to produce either industrial technicians or engineering technicians. Trade-level and craft-level programs are specifically excluded, as are preprofessional programs of the pre-engineering or engineering science varieties. Curriculums intended to train teachers of industrial arts or vocational subjects are likewise excluded.

In addition, there needs to be an agreement, or at least a definition, of which fields or which curriculums are, in fact, related to mechanical engineering. Since job titles and industrial classifications for technical personnel are more diverse and contradictory than curriculum titles, it is proposed that the reader consider the curriculums in Table 1 as "technologies related to mechanical engineering." Note that the list has been separated into two groups; those which are related almost exclusively to mechanical engineering (single-field emphasis) and those which are hybrids having a major relationship to mechanical engineering and at least one other engineering discipline (multifield emphasis).

Table 1

Technologies Related to Mechanical Engineering

Single-Field Emphasis

1. General
   a. Mechanical technology
   b. Mechanical engineering technology
2. Design
   a. Mechanical design technology
   b. Mechanical design engineering technology
   c. Machine design technology
3. Production
   a. Production technology
   b. Production engineering technology
   c. Industrial production technology
   d. Machine processes technology
   e. Manufacturing technology
   f. Tool and manufacturing technology

4. Drafting
    a. Design-drafting technology
    b. Drafting technology
    c. Drafting and design technology
    d. Engineering drafting technology
5. Power
    a. Mechanical power technology
    b. Mechanical power engineering technology
    c. Diesel-gas turbine technology
    d. Internal combustion engines engineering technology
    e. Fluid power technology
6. Materials
    a. Materials engineering technology
    b. Metallurgical technology
    c. Metallurgical engineering technology

Multifield Emphasis

1. Environmental
    a. Air conditioning technology
    b. Air conditioning engineering technology
    c. Heating and air conditioning technology
    d. Environmental control technology
2. Transportation
    a. Aeronautical technology
    b. Aeronautical engineering technology
    c. Aeronautics and space engineering technology
    d. Aerospace engineering technology
    e. Aircraft design technology
    f. Aircraft maintenance technology
    g. Automotive technology
3. Other
    a. Biomedical engineering technology
    b. Electro-mechanical technology
    c. Instrumentation technology
    d. Instrumentation engineering technology
    e. Industrial engineering technology
    f. Nuclear engineering technology
    g. Petroleum engineering technology

To complete the mutual understanding of the spectrum of technical personnel with which we are concerned, Table 2 lists a few typical functions and responsibilities of graduate technicians in fields related to mechanical engineering. Most functions performed by these technicians are white collar or white collar plus lab coat in nature.

Table 2

Some Typical Functions and Responsibilities of Technicians In Fields Related to Mechanical Engineering

A technician may perform one or a combination of the following functions and responsibilities:

1. Set up, instrument, and carry out or supervise tests on experimental equipment and processes

2. Take measurements, record data, make computations to reduce data, plot graphs, analyze results, and write technical reports

3. Solve routine design problems determining loads, stresses, mechanisms, gear trains, weights, fits

4. Trouble-shoot and diagnose malfunctions in laboratory, prototype, or production equipment, systems, or processes

5. Provide technical supervision in installation, start-up, and checkout of equipment and systems

6. Act as liaison to coordinate engineering instructions with production department

7. Serve as field service representative or technical salesman

8. Prepare sketches, detail, working, and assembly drawings from ideas, specifications, and calculations of engineers and designers

9. Supervise the work of lower-grade technicians

10. Assist engineers by obtaining data and information from sources such as technical publications, salesmen, customers, and other engineers.

Basic Data

In recent years, increasing attention has been focused at the national level on measurement and forecasting of technician needs, enrollment, and graduation patterns for technician training institutions, salaries of technicians, and other related data. Major studies in these areas are periodically conducted by the Engineering Manpower Commission (EMC) of the Engineers Joint Council and the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor. These studies are extremely valuable in evaluating national trends, and the findings, summarized below, are drawn primarily from these sources.

While it is essential for a consultant to be aware of the broad picture, national data may be of secondary importance in specific engagements. Consultants for an individual institution, a municipality, or a state agency need to have local and regional information subdivided into particular occupational areas. While national statistics do not frequently reflect local and regional conditions, they may be more reliable trend indicators since they deal with the total economy and are not as susceptible to rapid fluctuations.

A further problem in working with national studies lies in the coarse grouping of occupational specialties. Thus, a recent BLS study subdivides technical manpower into four occupational categories — draftsmen, engineering and physical science technicians, life science technicians, and other technicians. Consultants interested in data on mechanical engineering technicians, for example, will need to estimate the fractions of appropriate groups which represent these technicians.

Demand for Technicians

Similar estimates were necessary to approximate future requirements for technicians in fields related to mechanical engineering for the purposes of this paper. A technical manpower study by the New York State Department of Labor[1] was chosen as the basis for the following estimates of the proportions of such technicians among the overall group of technicians. These data reflect the employment conditions in New York State and the nation as a whole, or the dynamics of industrial and employment changes since 1962, except as they are incorporated in national projections.

In spite of this flimsy basis, calculations have been made to generate order-of-magnitude estimates of the needs for the kinds of technicians under consideration.

In 1966, the Bureau of Labor Statistics issued a comprehensive report[2] on the supply and demand for technical manpower using 1963 as the base year and projecting to 1975. Table 3 gives the national technician employment figures from this BLS report.

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[1] *Technical Manpower in New York State*, 2 vols. Division of Research and Statistics. New York: New York State Department of Labor, December 1964.

[2] *Technician Manpower: Requirements, Resources, and Training Needs.* Bureau of Labor Statistics, United States Department of Labor, Bulletin No. 1512. Washington: Government Printing Office, June 1966).

Table 3
Estimated Technician Employment in the United States[1]

Category	1963		1975 (Projected)		Increase (1963-75)	
	No.	%	No.	%	No.	%
Draftsmen	232,000	26.4	375,400	25.1	143,400	61.8
Engineering and physical science technicians	439,000	52.0	770,100	51.5	331,100	75.4
Life science technicians	58,100	6.9	139,200	9.3	81,100	139.5
Other technicians	115,700	13.7	210,200	14.1	94,500	81.8
Total	844,800	100	1,494,900	100	650,100	77.1

Practically all of the technicians with whom we are concerned are subgroups within the first two categories.

In addition to the foregoing needs from 1963 to 1975, due to industrial growth, an estimated 120,000 technicians will be required due to deaths and retirements, and about 260,000 technicians will be needed to offset losses due to transfers to other occupations.[2] Therefore, a total requirement of about 1,030,000 new technicians is forecast for the period. The associated requirements for the individual categories are shown in Table 4.

Table 4
Requirements for New Technicians in the United States, 1963-1975

Category	Employment Growth	Losses Due To		Total
		Death & Retirement	Transfer	
Draftsmen	143,400	31,100	67,400	241,900
Engineering and physical science technicians	331,100	62,000	134,400	527,500
Life science technicians	81,100	10,100	21,800	113,000
Other technicians	94,500	16,800	36,400	147,700
Total	650,100	120,000	260,000	1,030,000

[1] *Ibid.*, pp. 84, 86.
[2] *Ibid.*, p. 56.

Note: Losses were prorated according to the average number of technicians employed in each category over the period. The factors used were 25.9 per cent, 51.7 per cent, 8.4 per cent, and 14.0 per cent, respectively.

Demand in Fields Related to Mechanical Engineering

To determine the number of these technicians who are in occupations related to mechanical engineering, the proportions from the New York State study cited earlier were assumed to apply. Based on the classifications used, it is estimated that 60 per cent of the draftsmen and 30 per cent of the engineering and physical science technicians are in occupations related to mechanical engineering. Thus, the numbers of technicians required in occupations related to mechanical engineering are approximately as given in Table 5.

Table 5

Estimated Employment Requirements for Technicians in Occupations Related to Mechanical Engineering in the United States, 1963-1975

Category	*Technician Employment*		*New Technicians Required, 1963-1975*			
			Employment Growth	*Losses Due To*		*Total*
	1963	*1975*		*Death & Retirement*	*Transfer*	
Draftsmen	140,000	225,000	85,000	19,000	40,000	144,000
Engineering & physical science technicians	130,000	230,000	100,000	19,000	40,000	159,000
Total	270,000	445,000	185,000	38,000	80,000	303,000

This estimate indicates that three out of ten new technicians required by industry during the 1963-1975 period will be needed for occupations related to mechanical engineering.

Supply of Technicians

The Bureau of Labor Statistics considers that while some employers will upgrade skilled workers to technician jobs as a matter of promotional policy, most employers use upgrading[1] as a source of technicians when the supply of trained technicians is insufficient to meet the demand.

[1]Upgrading, as used here, includes no formal training program.

Therefore, the number of new entrants to technician jobs through upgrading from lower-level positions is a flexible quantity depending upon demand and the trained technician supply.

The total supply of trained technicians includes the following sources:[1]

1. Postsecondary technician programs
   a. Technical institutes, junior colleges, community colleges
   b. Extension divisions in colleges and universities
   c. Area vocational-technical schools
2. Four-year colleges and universities, graduates and dropouts
3. Government training programs (MDTA)
4. Armed forces technician separations
5. Employer technician training programs
6. Secondary school programs.

Of these sources, the number of high school graduates of preoccupational, technician training programs is believed to be small and most are not immediately qualified for technician positions without further training. For these reasons, the BLS has not projected new entrant technicians from this source.

Supply of Technicians from Postsecondary Technician Programs

The major source of trained technicians in both quantity and quality is from postsecondary programs. The majority of full-time students in these programs are recent high school graduates. High school graduates are projected to increase by two-thirds from about 1.95 million in 1963 to 3.24 million in 1973. During the 1962-63 academic year approximately 2 per cent of high school graduates of the prior two years were enrolled in postsecondary technician training programs. This proportion is expected to increase and then level off in the 1970's.

The total enrollments in postsecondary technician programs are expected to triple by 1975. The number of graduates is estimated at 27.5 per cent of total enrollment for 1963, increasing to about 33 per cent by 1975. A constant proportion of 65 per cent of these graduates are assumed to enter technical jobs over the period. Thus, 434,000 technicians will enter technical occupations from postsecondary training programs over the period 1963-74, or an annual average of about 36,200. The technicians which most interest us are included in this group, but further analysis will be necessary to estimate their numbers. Before attempting this, let us complete the projected supply picture according to BLS.

[1] *Technician Manpower, op cit.*, pp. 34-36.

Supply of Technicians from Other Sources

Entrant technicians from four-year colleges and universities with baccalaureate degrees, or dropouts with two or more years of college work in an engineering or science-related program are estimated to total about 108,000 over the period 1963-74.

Dropouts with two or three years of college are expected to amount to 10,000 engineering students per year and 25,000 science students per year from 1963-1974. Of these, 25 per cent of the engineering dropouts and 5 per cent of the science dropouts are expected to enter technician jobs.

Government-sponsored MDTA programs are expected to expand during the 1960's and then hold constant for the remainder of the period. Roughly 2 per cent of all MDTA trainees were being prepared for technician jobs since the inception of the program. This proportion is assumed to hold throughout the period. Of the 70 per cent who complete MDTA training, about 65 per cent are expected to enter technician jobs totaling about 40,700. The great majority of entrants from this source will become draftsmen.

About 3 per cent of the total armed forces separations of persons with technical training are estimated to enter civilian technician jobs directly. This source is expected to produce about 15,800 new entrants over the period.

The number of technicians produced by employer training programs varies inversely with the number of recruitable trained technicians from other formal sources. Employers tend to prefer new entrants with pre-occupational training, particularly at the associate degree level. Furthermore, broad-based training programs are costly for industry. Therefore, a decline in entrant technicians from industry training programs is projected at a rate of about 2 per cent per year. This source will continue to be the second largest supplier of trained technicians, providing an estimated 232,800 new entrants during the period 1963-74.

Not all new entrants during the period 1963-1974 will still be in technician jobs in 1975. About 3 per cent of employed technicians transfer to other occupations each year, while others will die or retire during the period. The BLS used actuarial tables to determine these latter losses based on the target year 1975. Therefore, the net supply data are not valid for intervening years since different working life calculations would be necessary for any other year. Also, it is risky to use simple proportions to determine the number of 1975 survivors in technical jobs for any subgroup in our total supply for two reasons. First, the ages at entry may be significantly different between subgroups, and therefore, their longevity will differ. Secondly, the more highly trained subgroups will tend to be more mobile occupationally and so more of one group may transfer upward to professional titles. Both of these factors operate with our interest group of associate degrce gradt .ttes. They typically enter t. chnical jobs at early ages and are more upward mobile than most other groups, except for the college and university graduates. For our group, however, these factors tend to offset each other and, since they constitute the largest element in the BLS figures, it is assumed that the total survival and retention rates apply to associate degree graduates.

The net cumulative supply of entry technicians from all formal sources is summarized in Table 6.

Table 6

Summary of Net Supply of Trained Technicians 1963-1974

Source	*No. Entrants To Technician Jobs*	
	Total 1963-1974	*Annual Average*
Postsecondary technician programs	434,000	36,200
Four-year college grads & dropouts	108,100	9,000
MDTA programs	40,700	3,700
Armed forces technician separations	15,800	1,300
Employer technician training	232,800	19,400
Total entrants	831,400	69,300
Number still in technical jobs in 1975	678,000	56,500

Supply in Fields Related to Mechanical Engineering

There was a general lack of information from which to estimate the portion from all sources of the technician supply trained for occupations related to mechanical engineering. The most useful data for these purposes are provided by the Engineering Manpower Commission, which in January 1968 issued a summary report[1] on enrollments in engineering and

[1] *Engineering and Technician Enrollments, Fall 1967, Summary Report.* Engineering Manpower Commission. New York: Engineers Joint Council, January 1968. Also see John D. Alden, "Engineering and Technician Enrollments in ECPD-Accredited Curricula, Fall 1967," *Journal of Engineering Education*, vol. 58, March 1968. pp. 837-842.

technician curriculums. The section on technicians provides an approximation of national registers in full and part-time programs of at least two years length leading to associate degrees or the equivalent. Furthermore, summaries are given by curriculum area which allow an estimate of the proportion in technologies related to mechanical engineering.

Table 7 gives an estimate of the numbers of these students who are in fields of training related to mechanical engineering. Proportions were applied equally to both full and part-time students.

Table 7

Estimated Enrollments in Associate Degree or Equivalent Programs Related to Mechanical Engineering, Fall 1967

Curriculum Area	*Assumed Percentage Related to Mechanical Engineering*	*Enrollments Related to Mechanical Engineering*		
		Full-Time	*Part-Time*	*Total*
Aerospace	100	3,628	580	4,208
Civil and related	0	....	....	....
Drafting and design	75	12,000	3,600	15,600
Electrical and electronics	0	....	....	....
Mechanical and related	100	17,176	7,565	24,741
Other technology	0	....	....	....
Total engineering technicians	....	32,800	11,750	44,550
Physical science and math technician	10	450	150	600
Industrial technician	50	4,700	2,600	7,300
Total all technicians	....	37,950	14,500	52,450
Per cent of group		37.1	21.5	30.9

Note: Because of rounding, the sum of individual items may not add to totals.

The next step was to estimate the proportion of 1968 graduates from these enrollments. Data from an earlier EMC report[1] show estimated graduates versus enrollments for the 1966-67 academic year. Based on these indications it was decided to use the proportions given in Table 8 to determine the numbers of graduates shown.

[1] *Trends in Engineering Technician Enrollments and Graduates.* Engineering Manpower Commission. New York: Engineers Joint Council, July 1967. pp. 11, 26.

Table 8

Estimate of 1968 Technician Graduates Related to Mechanical Engineering

Curriculum Area	*Graduate-To-Enrollment Ratio*		*Graduates Related-To-Mechanical Engineering*		
	Full-Time	*Part-Time*	*Full-Time*	*Part-Time*	*Total*
Total engineering technicians	.28	.08	9,200	950	10,150
Physical science and math technicians	.20	.08	90	10	100
Industrial technicians	.38	.20	1,800	500	2,300
Total					12,550

In earlier projections from 1963 to 1975, the 1968 figures were approximately equal to the annual average for the period.

Table 9

Estimated Associate Degree Graduates, Entry Technicians, and 1975 Survivors in Fields Related to Mechanical Engineering, 1963-1975

	Graduates	*Entry Technicians*	*Number Still in Technician Jobs in 1975*
Total 1963-1974	150,000	98,000	80,000
Annual average	12,550	8,200	6,650

Table 10

Comparison of Technician Surveys[1]

	EMC Surveys		*BLS Projections*	
	Total Enrollment	*Total Grads*	*Total Enrollment*	*Total Grads*
1965-66	111,979	22,552	153,000	42,800
1966-67	123,016	30,197	178,300	50,800
1967-68	169,545	35,200[2]	191,600	55,600

[1] *Trends, op. cit.*, pp. 11, 26; *Engineering and Technician, op. cit.*, p. 13; *Technician Manpower, op. cit.*, p. 65.

[2] Author's estimate, not EMC's, based on graduate-to-enrollment ratios assumed earlier.

It should be noted that when the three most recent EMC surveys are compared to BLS projections for the corresponding years, there appear to be substantial discrepancies (see Table 10). Two main differences probably account for a good part of the enrollment gap. First, BLS figures include estimates for life science technicians including medical and dental while the EMC excludes these technicians. Secondly, starting with the 1967-68 survey, the EMC has included only those industrial technicians in programs of two years or longer, whereas the BLS and prior EMC data include industrial technicians in programs of one year or longer. These two factors very likely determine the difference in enrollments for 1967-68, while the differences for earlier years are at least partially due to incomplete coverage of EMC surveys.

The differences in enrollments, however, do not explain the differences in graduates. The differences of about 20,000 graduates in each of the two earlier years could hardly be due to enrollment gaps of 41,000 and 55,000. Furthermore, if the estimate of graduates is within ± 20 per cent error, the difference for 1967-68 cannot be accounted for by a 22,000 enrollment gap. We are therefore led to the conclusion that the BLS proportions of graduates from given enrollments are too high, although the enrollments are within reasonable range of actual experience. We should therefore anticipate a lower supply of highly qualified technicians than is indicated by the primary BLS projection shown earlier.

As in the case of demand estimates, the BLS developed two alternate supply projections for the period.

If it is assumed that the estimate of 35,200 associate degree graduates in 1968 is correct, that 65 per cent of them enter technician jobs, and that the 1968 figure is the annual average for the entire period, then one may project a total of 22,900 new entry technicians per year. If it is further assumed that the "missing" 22,000 enrollees between EMC and BLS 1967-68 figures exist, they would probably represent about 8,000 additional graduates or about 5,000 more new entry technicians. Under these assumptions, the total contribution from postsecondary technician programs would be 28,000 new entry technicians and 335,000 total entrants for the period. Comparing these figures with the alternate supply projections, it would seem that the supply from this one important source would lie between the low of 23,900 and the intermediate of 36,200. If this occurs, the overall actual supply will be drawn to the low side unless there is a major increase in employer training to offset this effect.

Let us return to the supply-demand situation for technicians in fields related to mechanical engineering. The previous projection was a need for 303,000 new technicians of these types. We will supply about 98,000 associate degree entry technicians during the period, of which only 80,000 will stay to 1975. The remainder (205,000) will need to come from other formal sources and upgrading, although no attempt has been made to determine the proportions in mechanical engineering-related fields for the other sources due to insufficient data. Table 11 gives a summary of the supply of associate degree mechanical engineering-related new entry technicians with an allowance of ± 20 per cent compared to the three projections of requirements.

Table 11

Alternative Supply and Demand Estimates for New Entry Technicians in Fields Related to Mechanical Engineering

Level of Supply of Associate Degree Entry Technicians		*Level of Demand*		
		High	*Intermed.*	*Low*
High	Total Required	390,000	303,000	266,000
(+20%)	Assoc. Deg. Supplied	117,000	117,000	117,000
Supply	Remainder	273,000	186,000	149,000
Intermediate	Total Required	390,000	303,000	266,000
Supply	Assoc. Deg. Supplied	98,000	98,000	98,000
	Remainder	292,000	205,000	168,000
Low	Total Required	390,000	303,000	266,000
(−20%)	Assoc. Deg. Supplied	78,000	78,000	78,000
Supply	Remainder	312,000	225,000	188,000

If the demand level is either intermediate or low, upgrading capacity will probably be used to close any existing supply gaps. However, if the demand level is high, serious shortages may exist even if maximum upgrading levels are used. Here, again, associate degree graduate technicians in fields related to mechanical engineering should find excellent employment opportunities for the projected period.

Areas To Watch

Certain areas will bear watching, although most associate degree graduates are flexible enough to adapt to a variety of industries. One such area is the aerospace industry. Civilian space spending which peaked at $5.9 billion in 1966 has dropped to $4.7 billion in 1968 and is expected to drop much lower in the following years. Corresponding decreases in employment on space projects have occurred with officials estimating a drop to 270,000 by July 1968 from 1966 levels of about 420,000.

California, with one-third of all aerospace and aircraft manufacturing and one-fourth of all NASA contract funds, will feel the brunt of these changes. There have been several counterbalancing factors that will cushion the effect on the industry. Most important is the increase in sales of aircraft and parts, which rose 35 per cent last year to $4.9 billion. Several large orders by commercial airlines should continue the trend. While the aerospace industry is in trouble, the rest of the economy continues to expand. A record increase in the Gross National Product of $20 billion in the first quarter of 1968 to a new high of $827.3 billion and a new record for March in industrial production indicate the high expansion rate. However, government officials and economists are deeply worried about the effect this growth will have in stimulating imports, thereby causing further deterioration in the position of the dollar. They cite the last quarter of 1967 when the GNP rose by $16 billion, but almost half of that was due to increased prices rather than improved productivity. Also the spurt in foreign car sales to almost 1 million units will have an obvious effect on our balance-of-payments position. These factors, superimposed on the uncertainty about Viet Nam, have caused a hesitation in some areas of industry, particularly in orders for long-term delivery of heavy machinery.

The consensus of economists and businessmen on the effect of peace in Viet Nam on the economy, as reported in the *New York Times* (April 17, 1968), was that the direct results of lower military spending would be small, and would be more than absorbed by diverting resources into the cities to deal with the urban crisis.

Another area which will directly influence many technicians is the rate of utilization of automated equipment for drafting and designing. A Department of Labor Manpower Research Bulletin discusses the problem in these terms.[1]

"The impact upon numbers of draftsmen required will vary substantially among industries and types of drafting activities. The greatest effects from technological changes will occur in two industry groups. The first includes medium and large establishments in industry classifications where technological change will have a perceptible, but not extensive, effect. The second includes medium and large establishments in industries in which the impact from technological changes is expected to be most significant. The former group employs 28.2 per cent of all draftsmen, the latter, 29.1 per cent.

[1] *Technology and Manpower in Design and Drafting, 1969-75*. Manpower Research Bulletin No. 12, Manpower Administration. Washington: United States Department of Labor, October 1966. p. 4.

Within these groups, maximum reductions from technological changes of 10 per cent and 25 per cent respectively will be more than offset by expected growth in demand for drafting services. Employment in these two groups can be expected to grow from the present 114,300 to at least 173,300 by 1975. The group of draftsmen working on dimensional drawings, such as those required in complex mechanical design, will be least affected within this ten-year period.

"The use of time-shared graphics systems will have a significant impact upon the number of draftsmen required. The effects from these systems will still be numerically small by 1975, but their rapid diffusion after 1975 may substantially reduce the demand for draftsmen between 1975 and 1985."

Other Trends

The EMC 1966 survey included an opinionnaire for employers of technicians on certain future trends.[1] The three questions dealt with changes in the composition of technician staffs over the next decade.

Thus, 62 per cent of all respondents expected the ratio of technicians to engineers and scientists to increase, while only 4 per cent expected a decrease. Similarly, most respondents (70 per cent) indicated that their industry will train an increasing number of technicians over the next decade, while 5 per cent expected a decrease in number of industry-trained technicians. Finally, the employers were asked how the proportion of newly hired personnel who are technical institute graduates will change. A total of 81 per cent of the respondents predicted increasing proportions of such graduates among newly hired personnel. Only 3 per cent expected this proportion to decrease.

Another trend of vital concern is the growth of four-year technology programs. The EMC[2] reported 1,143 graduates from such programs in 1965-66, and included three papers on the subject in the same report. The effects of four-year programs on associate degree programs and on the supply of technicians will depend to a great extent on the formats and relationships which develop.

Salaries of Technicians

One of the distinguishing characteristics of associate degree technicians has been their upward mobility in responsibility and earning power. The EMC issued a comprehensive report[3] in 1966 which demonstrates the

[1] *Trends, op. cit.*, p. 33.

[2] *Ibid.*, p. 26.

[3] *Salaries of Engineering Technicians, 1966.* Engineering Manpower Commission. New York: Engineers Joint Council, July 1966.

kinds of salary differentials which graduate technicians earn over nongraduates. While the data represent a single year's survey and are without benefit of historical trend information, the results clearly show the earnings value of completing a technician education program.

In the words of the report.[1]

"Probably the most significant finding of this survey is that graduates of technical institutes and similar schools appear to command noticeably higher salaries at all levels, when compared with technicians in general. As explained later, there may be some question as to equivalency of experience in these two groups, but the differential in salary is unmistakeable. For the first fourteen years or so, the difference averages about $1,000 per year in favor of the graduates. Beyond that point, there appears to be a strong divergence in the salary patterns, presumably reflecting basic differences in employment functions. Median salaries of nongraduate technicians flatten out after fourteen years and rise very gradually to a maximum of about $8,600 per year. Graduate technicians, on the other hand, continue to enjoy increasingly higher salaries. Their median rises above $13,000 per year at 21-25 years of experience, then tapers off to the end of the chart."

From the data given for graduate and nongraduate technicians in all industries,[2] one can extract a rough estimate of the value of associate degree-level technician training compared with nongraduate technicians. By comparing corresponding medians, I estimate an advantage to graduates of more than $10,000 for the first ten years in industry, $35,000 for the first twenty years, and $80,000 for the first thirty years in the field.

Furthermore, the curve of the graduate technician's median salary closely parallels the lower quartile curve for engineers,[3] with the technicians earning between $1,500 and $2,000 less per annum for the first sixteen years. After this, the curves merge and the technician curve peaks a bit higher, and later drops off faster than the lower quartile engineers.

ISSUES AND PROBLEMS

The previous portion of this paper was intended to establish ground rules and present some basic information related to establishing the need for technicians, and hence a technician training program. The next important step in technician education process is to address oneself to some of the critical issues and problems as follows:

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[1] *Ibid.*, p. 7.
[2] *Ibid.*, p. 17.
[3] *Trends, op. cit.*, p. 6.

1. How can we more effectively attract potential technicians?
   a. How can we improve public relations and public information?
   b. What publics are we trying to reach? How?
   c. Are we competing for students? With whom? For which students?
   d. How can we improve relations with feeder high schools? With guidance counselors? With high school students?
   e. What factors tend to attract students to mechanical technology and related programs? What factors tend to discourage potential applicants?
2. How can we improve the match between the ability spectrum of applicants, the requirements and objectives of our curriculums, and the spectrum of technician occupations in our area industry?
   a. What range and optimum ability levels do we seek? Who applies? Who should apply? How to identify?
   b. How can we help match students and curriculums? What choices are available? To what extent are we responsible for sorting and matching? How well do pretechnical and remedial programs work?
3. What roles do we have in helping to meet social needs?
   a. What differences exist in the social needs of urban, suburban, and rural areas? What regional differences? What similarities?
   b. How can we attract more potential technicians from low-income groups and from minority group populations? What techniques work? Why?
4. In what ways can we attract women students to mechanical engineering-related technology programs?
   a. Which programs will attract women? Why?
   b. Is it realistic to expect to attract women as technician students?
5. What minimum levels of industrial demand and student supply justify initiating a new curriculum?
6. What factors other than minimum I/O requirements are involved in justifying new technical curriculums?
7. What are the needs for continuing education of graduate technicians? Of dropout technicians?
   a. Should junior colleges offer postgraduate courses? What results? What limitations?
   b. What effects will B.S. in technology programs have on associate degree programs? What formats will attract more students and serve institutions and industry best?

c. What patterns of further education do graduate technicians demonstrate? From engineering technician programs? From industrial technician programs?

8. How can we plan to respond to forecasts of changing needs for certain categories of technicians?
   a. What is the future of drafting technology programs?
   b. How can we meet the increasing demand for interdisciplinary technicians, e.g., electro-mechanical?

These are but a few of the issues to which the consultant may be asked to respond during the consultative process.

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DISCUSSION BY PARTICIPANTS

There is a well-documented need for all kinds of technicians in the various fields related to mechanical engineering. This need for technicians far exceeds the supply being generated by the educational institutions. One of the abiding problems in producing enough technicians lies in the problem of recruiting appropriate students for technician training programs. In many parts of the country, technician training programs are available but there is a lack of qualified students to fill the available classroom space. If adequate numbers of technicians are to be trained for the needs of business and industry, more vigorous and innovative recruiting programs must be planned.

Overall occupational guidance should begin at the junior high school level. At this level the student should be aware of the various career alternatives including a career as a technician. More information concerning the opportunities in mechanical engineering technology should be supplied to the parents of students, for it is a recognized and documented fact that the suggestions of parents frequently influence the career choice of their children.

Schools wishing to recruit technology students should work more closely with industry in student recruiting. In most cases industry is most cooperative in providing information for guidance programs, and many industries have films and guidance materials that are available for distribution through the schools.

It has been expressed by some technical educators that one of the problems contributing to the lack of qualified students in post-high school technology programs lies in the fact that most high school graduates are not prepared to enter technology programs upon graduation. This emphasizes the need for pretechnology programs available in the eleventh and twelfth grades in high schools.

With many high school students and their parents, the baccalaureate degree is the "great American dream." Therefore, any kind of post-high school education program that is "terminal" in nature or does not lead to a baccalaureate degree is many times viewed as undesirable. In recruiting for post-high school technical programs, it must be emphasized that education is never terminal and that for the qualified person who is motivated to achieve higher educational levels, there are always many options for continuing education. The introduction of the four-year technology programs in institutions around the country may provide great assistance in negating the terminal stigma of the associate degree program.

In recommending the start of new technology programs based on local industry needs, care must be taken that these estimates are accurate. It has been found that some single industry manpower-need-surveys are inflated and reflect the number of "well-trained" technicians that the industry would like to hire and not the number of new positions that are anticipated within the immediate future. For every technician graduated from a program, there should be a job available for that graduate. Employability of technician graduates is the key criterion for judging program success.

Statistics of manpower needs upon which new mechanical technology programs can be based, may be gathered at the local, regional, or national level. Consequently, an institution initiating a new program must necessarily decide which needs it will serve. When an institution receives a substantial amount of local funds, local manpower demands and local placement may be of primary importance to the institution. Where institutions are privately funded or receive state funds, an institution may be more likely to design its curriculum to meet the needs of state, regional, or national manpower requirements. However, this is a fundamental philosophical commitment that must be made by the training institution at the outset.

In determining manpower needs, the survey should include needs for the complete spectrum of technician jobs in the technology being surveyed. This includes technician-level jobs from the very low-level, skill-oriented positions to the high-level engineering technician which operates close to the professional engineering level. This all-inclusive manpower data is essential for long-range planning of a comprehensive program to meet both the needs of industry and the community served. If there are manpower needs at all levels, the institution may then decide what kind of program it will implement. This decision may be made on the basis of facilities, equipment, and potential staffing. However, with manpower data that indicates a need for technicians at various levels of sophistication, it may be possible to initiate a multilevel technician program that will satisfy the needs and capabilities of a wide range of students.

Built into every manpower study, there should be a student availability study. In addition to jobs being available for technician graduates, there must be an adequate supply of potential students within the area served by the institution if the program is to be successful. Programs should be devised for a wide spectrum of student abilities. In addition, consideration in program planning should be given to special education needs. This would include programs for adults and special groups with educational handicaps. Where there are significant groups of potential students with poor preparation for postsecondary technology programs, programs should be devised to bring these students up to a pretechnology level that will allow them a reasonable chance for success in the program.

When basing new technology programs on manpower needs, the implementation of programs for the needs of a single employer should be avoided. When an educational program depends upon one employer for consumption of the educational product, placement may be difficult as the economy of that employer or industry declines. As technology changes, employment needs change for any single industry. However, in planning and implementing new programs, there is a vital need for close cooperation with the entire industry surveyed. In making the manpower survey, every effort should be made to have industry specifically define jobs that are available or will be available so that a clear picture of manpower needs and training needs can be determined by the educational institution.

CURRICULUMS FOR TECHNOLOGIES RELATED TO MECHANICAL ENGINEERING

by

SAMUEL PETERSON*

In the formal development of a curriculum, the first step to be taken is the development of a *target pattern*. This target pattern constitutes an agenda for subsequent meetings of the staff, faculty, and advisory committees. It does not necessarily represent the final document that puts the show on the road. In fact the target pattern seldom represents the eventual college catalog entry. However, just like a motion on the floor before the discussion, it serves to keep the efforts of all concerned on down-to-earth considerations rather than pie-in-the-sky dreaming.

This target pattern should be developed through the cooperative efforts of a small working group composed of instructors and administrators. The instructors to be involved are the essential participants. If they can be made available, they should produce 90 per cent of *all* the work and 75 per cent of the quality endeavor. Although it is often considered necessary to develop the curriculum and later employ the instructors to fill the created vacancies, this is one of the more direct paths to initial disappointment. Almost every teacher considers himself an expert in academic matters as well as in his field of specialty. But most would agree that it wasn't until course outlines and facilities were modified to the teachers tastes and flairs—or more pertinently until he had developed his own curriculum—that he was able to perform most effectively.

The department head or division chairman should be involved. The administrator at this level is often a part-time classroom instructor with responsibilities for both instructor and program evaluation. Undoubtedly he has considerable responsibility for budget preparation, and might well serve in keeping some realistic focus on facilities and finances at this stage of the planning. If he is still in the classroom a good portion of the time, he should have a realistic understanding of classroom instructional needs.

Finally, if there is a top-level administrator serving as director or coordi-

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nator of vocational education, he can serve to bring gently to the planning table the experiences that are usually his regarding availability of federal and state assistance, his wide contacts with vocational educators in neighboring areas, and his contact with industrial personnel and agencies within his own area.

This target pattern usually consists of four elements:

1. A statement of the general requirement of the program: A big picture designed to assure approving agencies that we have a broad understanding of the problem.

2. The curriculum: A detailed chart of the course titles, class hours, and credit hours generally covering two years of training. The curriculum chart gives a picture of the packaging of the courses within the general time devoted to the training program.

3. Course outlines: Many patterns are appropriate. It is essential that the topics or learning units are so clearly delineated as to permit their use in the preparation of daily lesson plans; and more importantly, these lesson plans are designed to achieve attainable objectives. At this point one can get into some complex philosophical considerations. One might look at objectives as behavioral changes in the student which are developed as a result of the course and which make him more qualified to take his place in the adult world. Our problem may be less difficult than that of the social scientists, but at this stage of the game some uncluttered thinking must take place regarding skills required, behavioral changes desired, and their relationship to course objectives.

4. A facilities section: It should include a diagram of the classrooms, shops, and laboratories and suggest a list of required equipment with current prices.

To what degree of detail should the target pattern be developed? It should be developed to the greatest detail that can be begged, borrowed, or stolen. This suggests a document so clear and in such detail that men who know what they want and what they need can make decisions to approve, modify, or discard the listed proposals item by item. It keeps deliberative noses to the grindstone. Among the more galling aspects of planning is participating in committee deliberations compounded of ill-defined doubts, fears, uneasiness, wind, and philosophical consideration that normally accompany an ill-prepared agenda.

With reference to all the detail you can beg, borrow, or steal, the following two resource documents are listed for mechanical technology:

1. Technical Education program series No. 3 (OE-80019) Mechanical Technology—Design and Production, Office of Education, U.S. Department of Health, Education and Welfare.

2. Machine Design Technology—A suggested Two-Year Post-High School Program. Engineering Technology Series No. 1—A Curriculum Project sponsored jointly by the Illinois Board of Vocational Education and the University of Illinois.

If either of these documents approximate to any degree the type of graduate agreed upon, the instructor preparing the target pattern, using either document as a guide, can rapidly and easily incorporate his personal ideas and provide for his personal instructional flairs.

If neither of these documents meets the need, most technical educators are so proud of their efforts that with the slightest provocation they are willing to share curriculum patterns and course outlines with any college that requests them. A search of college catalogs for programs that satisfy our needs as we understand them is a most rewarding initial effort; particularly when colleges respond with sympathetic enthusiasm.

It is well to develop the habit of making frequent and specific progress reports. No time is more appropriate to initiate them than during the initial stages of planning. Top administrators who have the power to approve and implement have the right to know that progress is being made, and a right to have as clear a picture as early as possible of the cost and magnitude of the proposals being considered. It is equally the right of the planner to have early, timely, and continuous evaluation of his proposals to ensure that he can make appropriate adjustments to practical considerations that may not be within the scope of his wisdom.

Advisory Committees

With the target pattern completed, it is time to convene the advisory committee. For specifics it is recommended that the advisory committee consist of ten or fifteen members. To the group should be added one top-level administrator with the authority to make reasonable commitments regarding approval and implementation. The remaining members should be representatives of the industries the program is designed to serve. These representatives should probably constitute a balanced mix of personnel directors and immediate supervisors of the employees similar to those being trained. There is no escaping the desirability of involving representatives of industry that have the interest and the authority to employ the students who successfully complete the program. Nothing is more encouraging during curriculum deliberations than specific proposals and counter proposals in good faith that lead to firm and encouraging answers to such questions as, "If we properly implement this curriculum, can you assure entry positions and appropriate advancement opportunities for all who succeed?" Industrial representatives on advisory committees should be selected early and should be provided copies of the progress reports. At least two weeks prior to the meetings, they should be given the target pattern and appropriate additional agenda details.

In discussing advisory committee deliberations, the backdrop of the previously mentioned U.S. Office of Education Document may be used. A portion of this document is shown in Figure 1.

A core period and a specialization period is highly desirable.

CORE YEAR

FIRST TERM

Course Title	*Hours Class*	*Hours Lab*	*Credits*
Orientation	1	0	0
Materials of Industry	3	0	3
Mechanical Drafting I	2	6	4
Manufacturing Processes I	2	3	3
Mathematics I	5	0	5
Communication Skills	3	0	3
	16	9	18

SECOND TERM

Course Title	*Hours Class*	*Hours Lab*	*Credits*
Technical Reporting	2	0	2
Manufacturing Processes II	2	3	3
Mechanical Drafting II	2	6	4
Mathematics II	4	0	4
Mechanics & Heat	4	2	5
	14	11	18

SPECIALIZATION YEAR

DESIGN OPTION

THIRD TERM

Strength of Materials	3	2	4
Basic Mechanisms	2	9	5
Electricity	3	2	4
American Institutions	2	0	2
Hydraulics and Pneumatics	2	2	3
	12	15	18

FOURTH TERM

Machine Design	3	0	3
Basic Tool Design	1	6	4
Design Problems	1	9	5
Psychology and Human Relations	3	0	3
Industrial Organizations and Institutions	3	0	3
	11	15	18

PRODUCTION OPTION

THIRD TERM

Methods and Opns. Analysis	3	3	4
Statistics and Quality Control	2	2	3
Electricity	3	2	4
American Institutions	2	0	2
Hydraulics and Pneumatics	2	2	3
	12	9	16

FOURTH TERM

Plant Layout and Materials Handling	3	3	4
Process Planning	3	3	4
Production Problems	1	9	4
Psychology and Human Relations	3	0	3
Industrial Organizations and Institutions	3	0	3
	13	15	18

Figure 1

The U.S. Office of Education document prescribes a core year followed by a year of specialization in either design or production. It is highly possible that additional options of less academic rigor can be profitably spun off this basic core. Such options might be areas promising success to students who negotiate some aspects of the core year with less than outstanding achievement. Such options would in all probability run to areas that most of us would be hesitant to associate with the term technical, but they can be areas in which crying needs for special skills exist.

It is reasonable to believe that the conventional warfare between the general education requirements for the associate in arts or science degree, and courses required for preparation in the technology major and its allied requirements in mathematics and physical science can be avoided. It may be an oversimplification to suggest that the mathematics, physics, and technical courses be scheduled either in the morning or the afternoon, and the general education in the matching afternoons or mornings. However this procedure does allow the student to whom general education is an anathema or who must work part time, and opportunity to defer what to him are the debatable merits of the requirements for the degree and still have a reasonable opportunity to concentrate on the courses that develop the marketable skills.

Approval of the Curriculum Proposal

When the best possible match of industry requirements, student capabilities, and college resources has been achieved through the modification of the target pattern, one last check should be made before storming the final barricades to approval. This is the point to hire a consultant to evaluate the plan. If pitfalls exist or essentials have been overlooked, there is a strong possibility he can spot them quickly and propose rather easily implemented proposals for addition or modification. It is akin to insurance in some respects. In a nutshell, it is suggested that those who would venture into any new field of vocational education, do your homework then call in a good consultant to evaluate your paper.

If one has had a finger on the pulse of the top administrators through progress reports and their representation in committee deliberations, the road to approval should not be difficult; but don't overlook the island of resistance. Faculty senates are becoming increasingly interested in curriculum, and curriculum committees have varying degrees of approval power regarding proposals. These groups generally constitute a broad representation of the many facets in a comprehensive community college. Their interests and objectives may vary widely from those of the vocational educator; but in the squeeze of sharply rising enrollments and costs and less sharply rising assessed valuation, we find ourselves more often than not competing for the same dollar.

Take the trouble to study the nature and composition of the groups who have a say in curriculum approval. Sell your product to your possible supporters, isolate and defoliate your potential opposition with logic and arguments of substance, and treat curriculum committees for what they are—dedicated instructors and administrators who are busy men with other areas of responsibility equally demanding of their time. A little honest respect and understanding goes a long way in approaching these deliberative bodies.

Implementation and Evaluation

Of the many aspects germane to implementation of a new program, the one most applicable to the curriculum planner is the recruitment of students. Having sold the proposal, he is in the best position to sell the program. Several productive activities include the preparation of brochures and assuring their distribution to high schools, industry, and employment agencies; and preparation of essential ingredients for newspapers, trade and technical publications, TV and radio publicity, as well as presentation to high schools through conferences with high school counsellors, presentations on career days, and the sponsoring of field trips to college campuses.

Some instructors have written personal letters and distributed information to the parents of potential high school graduates, offering assistance in counseling and registration, and have submitted follow-up letters immediately prior to registration to confirm the good faith of their initial contact. Some enter the ghetto to carry the word. As one put it, "the message of vocational opportunity doesn't get across to the culturally deprived until you can meet them eyeball-to-eyeball in their own language on their own ground."

Another aspect of implementation to which the curriculum planner can make a real contribution is the surmounting of difficulties that have little or nothing to do with the eventual implementation of the approved program. They may involve incompatibility between the program and initially available funds or facilities. They may involve initial enrollment of less numbers than administrative or board policy dictates to be the minimum requirements for a new program. They may be difficulties inherent to competitive programs within the college or at adjacent institutions.

It is believed that as the budget squeeze grows tighter in the future, area-wide planning between institutions must become accepted as the logical solution to competitive offerings. Initial lack of means and initial lack of students might be accommodated, while fielding at least a trial or modified version of the program by satelliting its salient elements on existing curriculum patterns that have common core elements. Another solution where heavy vocational offerings are part of an extended day or evening college program is to introduce the new curriculum in that environment either as a satellite of an ongoing offering or its essential elements as an in-service or retraining offering for the night-school patron.

The principal tool for program evaluation is the quality of the product as demonstrated by ease of placement and the industrial supervisor's appraisal of the worth and advancement possibilities of the graduate. Initial placement is easy to measure. The follow-up study of productivity and advancement is more difficult; but if pursued with honesty and vigor, it is most rewarding in terms of program evaluation and subsequent adjustment.

After initiation of the program, annual advisory committee meetings can be profitable if the agenda is designed to limit the instructor's appraisal of his accomplishments (often an understandably biased point of view) and emphasize thoughtful appraisal by the industrial advisors of the curriculum specifics as they bear on performance of the graduate.

Classroom visitations are one method of instructor evaluation. They are often highly stylized. Most familiar are those that involve an hour's visitation followed by a conference with the instructor and a written report. These are satisfactory for accumulating evidence required to dismiss the probationary teacher. However, their value in improving instruction or programs is highly questionable.

In conclusion, we must continually stress to our customers the belief that while we deal in an area where the needs of the employer and the needs of the student are essentially compatible, and the satisfaction of one is the satisfaction of the other, it is the answering of the need of the student that is our paramount concern. Strong medicine is made these days of the large numbers going to college. We hide from general view the fact that only two of ten ever complete a full four-year treatment. It is with the remaining eight that vocational and technical educators are primarily concerned. This concern must be reflected in realistic and appropriate, quality curriculum offerings.

DISCUSSION BY PARTICIPANTS

In providing consulting services for institutions requiring assistance in planning and implementing new curriculums or revising existing curriculums, the consultant must realize at the outset that he can only suggest guidelines for the detailed work that must be done by the local staff after he leaves. Key areas for affecting curriculum design and revision that the consultant will want to discuss with the local program staff are: advisory committees, curriculum design parameters, accreditation, and sources for further curriculum help.

Advisory Committees

Advisory committees are invaluable in the development of curriculums based upon actual industrial needs. They can provide the essential "reality check" needed to develop new curriculums and keep an existing program up-to-date. Whenever possible, the curriculum advisory committee should also involve high school counselors and teachers. Besides providing a valuable input to committee decisions in terms of their technical expertise, high school counselors and teachers provide a valuable public relations resource for future student recruiting.

In the utilization of curriculum advisory committees, it should be emphasized that the committee serves in an advisory capacity and never sets policy. Furthermore, the curriculum advisory committee should be utilized for the professional assistance that it can provide; and the institution should be sensitive to its suggestions. The advisory committee should never be used as a "rubber stamp" group to provide administration support for curriculum decisions that have been made without their help.

Curriculum

Whenever possible, new programs should be designed based upon actual job descriptions and performance goals. Further, they should reflect the particular goals and needs of that institution. While curriculum outlines developed at other institutions may be used to a great advantage for overall guidance and ideas, they should never be replicated in exact detail. In designing new curriculums, continuous vigilance must be given to the goals of that program, with curriculum content based upon actual needs of the student to perform the identified cognitive or psychomotor task on the job.

Curriculum content should never be included just to make the overall program "rigorous". The quality of a technician education program is judged upon the final employability and performance of its product and never upon unjustified, nonfunctional hurdles designed to eliminate the average student.

In curriculum design, it must be realized that there sometimes exists "institutional givens" that must be taken into consideration in program development. Some of these given factors are state curriculum requirements, accreditation agency requirements, federal requirements, and unique constraints of professional associations.

Whenever possible, programs should be structured for various levels of entry-level students. This type of program allows a student to move up the technological ladder in accordance with his own abilities. It also provides a greater service to the total student community. Also, programs should be designed for the inclusion of individualized instruction modules in the curriculum. This accommodates the superior student and accelerated learner as well as the slower learner.

Continuing education programs play an important role in meeting special program needs of the community served. Generally, evening programs add a special strength and vigor to a department because of the more mature student groups enrolled, and the level of education already attained by students before entrance.

If conceivable, cooperative work-study programs should be considered. This allows students to "earn as they learn." It also effectively utilizes the facilities of industry for laboratory experiences.

A very valuable recruiting tool for technical curriculums may be developed through the cooperative efforts of area high school counselors. This may involve giving post-high school credit for certain courses the student may have taken in high school. If local or state legal restraints make this impossible, credit may sometimes be given by administering appropriate advanced standing examinations or validation examinations to justify post-high school credit.

In planning new curriculums, appropriate standards should be set based upon the curriculum, the types of students sought, and performance requirements of graduates on the job. These standards should be set at the outset and maintained. It is always a questionable strategy to start a new program with lowered program standards to accommodate large masses of students with the thought of later raising program standards. Invariably, standards are never raised and the program remains a mediocre one. This emphasizes the need for an adequate potential student population to exist within the service area of the institution before the new program is implemented. Programs can be offered with low enrollments for a period of time; but eventually, enough students must enroll in the program to make it self-sustaining.

It is essential that all technical curriculums and programs undergo continuous evaluation. It is necessary that the evaluation criteria be identified at the beginning of the program. Useful inputs for program evaluation are student placement, industry feedback, follow-up of students, accrediting agency reports, and advisory committees. However, the ultimate criterion of program success is the placement of program graduates in appropriate jobs.

Accreditation

Eventual accreditation must be considered in planning a new program. There are many types of accreditation available from a variety of agencies; and the type of accreditation sought must be determined by that particular institution. Accreditation can provide many strengths for a program. First of all, it can help students enrolled in the program by providing a base for transfer of credit. It can also provide a uniform type of recognition for program graduates. Accreditation provides a valuable mechanism for maintaining program quality. It can provide a uniform standard by which the evaluated program may be compared with other programs; it also forces institutional self-evaluation.

Sources of Curriculum Design Help

In preparing for the visit of the consultant, or in following up certain recommendations of the consultant concerning program design and implementation, an institution frequently needs additional help. One valuable source of assistance is in visitation to other institutions that have quality mechanical technology programs. Valuable insights may be gained by observing how other institutions operate a program where the curriculum content is designed to meet specific local objectives. Curriculum materials that have been developed and tested at other institutions are also available as valuable reference materials. There are three major sources or collections of these materials. These are as follows: (1) The American Association of Junior Colleges, OEP, Curriculum Library; (2) The Wentworth Institute Curriculum Library for ECPD Curriculums; (3) The ERIC Clearinghouse for Vocational-Technical Education.

INSTRUCTIONAL METHODS AND MATERIALS

by

ROBERT M. MICHAEL *

The consultant is generally engaged by a client for one of two reasons; to develop a new program or to improve an existing one. In either case, the consultant must have a broad knowledge of the educational materials and methods needed and used by educational institutions.

This paper is intended to suggest some methods and materials that may be used in curriculums related to mechanical engineering. Instructional materials cover such a wide range of types and purposes that it would be impossible to do more than scratch the surface in this discussion. However, some of the more common and basic teaching materials will be discussed; most of these are available in every educational institution and include course outlines, textbooks, lesson plans, laboratory equipment, and visual aids.

The course outline provides the structure of the course. It states the general objectives of the course and provides a general time schedule for presentation of the course material. Course objectives should be clearly indicated by the course outline. Clearly stated, curriculum objectives should also show the relationship of that course to the overall curriculum.

The course outline provides a control device to help assure uniform course-content coverage by all instructors. This control can vary in degree depending on the detail of the outline and the degree of administrative or departmental constraints.

The prerequisites for the course should be stated in the course outline; in addition, outside reference materials should be listed.

Course outlines should be specific enough to assure that the objectives of the course are reached, but flexible enough to allow the instructor to take advantage of his particular strengths and to allow for the different personalities of the classes.

The course objectives, as stated in the outline, should be such that if

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they are achieved, they make a definite contribution to the things that a student should know and be able to do when he graduates. The general elements that must be carefully considered in designing a course are optimum use and distribution of time, and logical sequencing of facts. This can be done as follows:

1. Determine the amount of time available. This would be the number of class periods less the time for examinations, field trips, and the possibility of unforeseen events.
2. Select the minimum amount of basic material that must be presented in the course. This is in part determined by the prerequisite material that has been covered. Additional material could be covered in accordance with the ability of the instructor and the interest developed by the class.
3. Schedule the appropriate amount of time for the material to be covered.
4. Determine type and level of problems to be presented.
5. Organize laboratory experiments to demonstrate and supplement lecture material.
6. Select textbooks and supplementary material.

All laboratory requirements pertaining to theory, procedures, methods, and equipment should be included in the outline.

Lesson plans are the detailed plans for each class period. The plans should meet the objectives of the course outline by emphasizing the basic points in each class period. The lesson plan should be flexible enough to take into account the daily variations in progress of the classes, with adequate provision to repeat points not clearly understood by a particular class. A list of all visual aids and supplementary material should be included in the lesson plan.

One of the most important benefits of lesson plans is that the course will be planned in advance. This should allow for greater use of visual aids and other supplementary material. Items to be considered in the lesson plan are: important facts, sequence of facts, presentation time allowed, summary, and visual aids to be used.

The textbooks for a course are usually obtained from commercial publishing houses; however, other sources should not be overlooked. Some of these are: government agencies, trade organizations, industry publications, and professional societies. Information from these sources may be in the form of books, papers, pamphlets, catalogs, tables, and graphs.

The level of material in the selected textbook is very important. It has been somewhat difficult in past years to find textbooks of the correct level for engineering technology programs. However, this problem seems to be diminishing. In the past these books have generally been written at the professional engineering level or the trade level. The material in the textbook should cover the basic points of the course outline, at the level required, with a minimum of required supplementary material.

The level of the text material must be considered from several aspects; first, the technical level of the material must be appropriate both in theory and practicality. Second, the mathematical level should be appropriate to the abilities of the students. Third, the practical level of the book should be such that it provides the student with suggested procedures and practices from which he will be able to generalize. (For example, a student who has received instruction in tool-and-die design should be able to design simple drill jigs, fixtures, and dies on the job with a minimum of supervision.) Fourth, the problems in the book or text materials should be appropriate.

Material to supplement the textbook should be used at every possible opportunity. This might include industrial catalogs, handbooks, pamphlets, charts, graphs, standards, and any other information source used by industry. Many companies are very willing to supply much of this material in quantities sufficient to give to each of the students. Other sources for this material are government agencies, professional societies and organizations, and trade organizations.

Laboratories should be equipped so that experiments can be performed to demonstrate the fundamental principles identified in the course outline. The equipment should be selected and the experiments should be planned so that they will require the students to learn the operative skills of the equipment. If possible, experiments should be performed on equipment of a wide variety of makes and models.

The importance of computers in the engineering field today makes it almost essential that engineering technician students have some introduction to the functional use of the computer. The computer can become a very excellent instructional aid and tool for both the students and staff.

Problems involving the use of the computer for solutions should be assigned wherever possible in the specialty courses of the curriculum. These problems should not necessarily stress the programing or operation of the computer, but should indicate to the student the wide variety of information that can be quickly obtained with the computer.

Television, with its great possibilities, is due special mention. It appears to work well in all areas of mechanical engineering instruction, from the demonstration of manipulative skills to a complete series of videotaped lectures.

The objective of instruction in any educational institution is to direct the learning process of the students toward understanding the principles and attaining the objectives specified in the course outline and lesson plan. To reach this goal, the best instructional methods or combination of methods should be used. Faculty and staff should continually try to improve their presentations and to develop new methods. To accomplish this upgrading of teaching skills, the institution should consider an in-service training program for keeping their instructional staff up-to-date in new teaching methods and educational technology.

The basic instructional methods most commonly used in the teaching of technical subject matter are lecture, discussion, seminar, and laboratory. The choice of method depends upon the objectives of the course, the equipment available, the instructor, the time allotted, and the peculiar needs of the class.

Lecture — This is the method most frequently used, probably because it demands less from the instructor. The lecture must be carefully planned in order to present the material clearly and in a logical sequence. The attitude and enthusiasm of the lecturer is a vital ingredient in a successful lecture.

Discussion — This method involves greater student interaction and allows the student to clarify facts through questioning. However, the discussion leader must be well prepared with the discussion outlined in advance.

Seminar — The seminar is a method for short-time, concentrated learning activity with views shared by several experts in the field.

Laboratory — Generally used in conjunction with other methods, the laboratory method of instruction is designed to demonstrate theoretical principles. The laboratories should be interdisciplinary where possible, especially in the use of measurement devices. The instrumentation should be of the type used by industry. The experiments should be relevant to the classroom instruction. The laboratory should require the student (or teams of 2-3 students) to become proficient in planning the laboratory work and in writing a proper laboratory report upon completion of the laboratory experience.

There are many ways to supplement these four instructional methods. One is the field trip. A trip through almost any engineering business or manufacturing facility is beneficial to students in the mechanical engineering area. However, field trips should be carefully planned. They should relate with the instruction in the classroom or laboratory.

The objectives of the field trip should be discussed in advance. These should cover the theory behind the product, the various manufacturing processes needed to produce the product, and the theory of these processes. Special note should be made of any specialized processes or equipment that will be inspected.

When possible, a short history should be given of the particular company to be visited. This will generally give some insights into any peculiar operations of the company.

Students should be required to submit written reports concerning the field trip.

Programmed instruction is another technique which should be carefully considered in the instructional process. There are at least three ways in which programmed instruction can be used with great results.

First, it can be used for remedial instruction to bring the level of certain students up to the point where they can fit into the regular instructional program.

Second, programmed learning courses may be integrated into the curriculum to provide supplemental work for specific courses or as a homework assignment.

Third, programmed instruction may be used as an updating device to keep curriculum offerings current. This can be done in areas extending from complex engineering theory to manipulative skills. Some examples of programmed courses offered by ASTME include courses in reading a micrometer, project management, numerical control, and many others.

The best of methods and materials will be useless if the institution does not have an able, qualified, and enthusiastic faculty.

DISCUSSION BY PARTICIPANTS

The selection and proper use of appropriate instructional media is an important facet in the success of any engineering technology program. It is therefore essential that the consultant be knowledgeable and up-to-date in the area of educational technology. Further, he must know how new media and teaching equipment can be used to enhance learning in his field.

Whenever possible, the development of a media center should be considered. This center can provide a centralized resource of audiovisual equipment and other media. The media center is often administered in conjunction with the library — one lending support to the other.

Laboratory equipment should be selected that is similar to that found in industry; however, because of the cost and size limitations, it does not have to duplicate industrial equipment. It should, however, teach the same principles as those learned on industrial equipment and should be such that there is a maximum transfer of learning for the student.

The computer is a basic tool for both the technician and the engineer in today's technical society. Therefore, some exposure to the use and capability of the computer is highly desirable for the mechanical engineering technician. Where a computer facility is not available to a program, the consultant should be thoroughly familiar with the alternatives of rental, lease-purchase, or use of relatively inexpensive computer remote terminals that might be appropriate for the client institution.

FACILITIES AND STAFFING FOR TECHNOLOGIES RELATED TO MECHANICAL ENGINEERING

by

HAROLD C. CUNNINGHAM*

Introduction

The objective of this discussion is to identify some of the problems that the consultant will face in regard to facilities and staffing for technologies related to mechanical engineering — also, to present an organized approach to solving some of these problems. Solutions cannot be given for all of the specific problems encountered, but suggestions will be made relative to the pros and cons of many of the items that a consultant will be facing when called upon to give judgments on facilities and staffing. It is assumed in this discussion that each of the following has taken place: the need has been identified; the curriculum has been established; and the instructional methods and materials are fairly well defined. This is not to preclude adjusting any of these parameters after consulting on facilities and staffing has taken place. In all likelihood, this will happen.

This discussion will treat four areas: classroom and equipment selection, facilities, staffing, and budget. None of these are mutually exclusive. The consultant should have all of these inter-relationships in his mind at the same time and constantly be evaluating them. Each area will be isolated for discussion purposes, and then will be tied together in the summary.

Classroom and Equipment Selection

For effective implementation of a curriculum, the classroom and equipment selection must be related to that curriculum and to the teaching methods that are used within that curriculum. The consultant might be asked to give the pros and cons relative to classroom configurations and equipment selection. To help arrive at these recommendations, the curriculum is broken up into topic areas, for example: machine tools, ma-

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terials testing, etc. Integrated with these topic areas might be office space and counseling services. Should the office space and counseling services be immediately adjacent to instructional areas? Should all of these areas be under one roof?

Additional considerations for the consultant might be the following: the decisions of "hands-on," demonstration, lecture, audiovisual, tutorial, or computer-aided instruction will shape the decisions on configuration of classrooms and laboratories. An advantage of a "hands-on" approach would be that the student is able to perform a certain mechanical manipulation and will gain (limited) experience in this skill. Some disadvantages are: capital investment, maintenance, supply and space requirements. The demonstration technique enables a college to cut down on capital expenditures, space, supply, and maintenance, while not enabling the student to have manually learned skills. Should industrial grade equipment be purchased? The industrial equipment would enable the student to practice on the type of equipment that would be found in industry; however, some other type of equipment may well teach the theory as well as the industrial grade equipment. What should be the capacity of the equipment? Would one horsepower do as well as five? Is obsolescence an important factor? Might it be wise for the consultant to recommend the rental of the equipment instead of purchasing? For example: one might recommend the purchasing of machine tools, while the leasing of a computer might be more feasible. Does maintenance have any relevance to equipment selection, or, for that matter, classroom configuration?

The sooner the consultant identifies restrictions and limitations, the sooner he will be able to make specific recommendations. The restrictions and limitations may be imposed by the curriculum, by the physical plant, by the administration in charge, or possibly by the budget. Any preliminary specifications for equipment or classrooms should involve local teachers, advisory committees, and possibly visits by the local teachers to other schools having a similar curriculum or using a similar type of equipment. Once a "model" is set up in terms of classroom space and equipment, the easier it is for the consultant to direct the reconstruction or enhancement of that model.

Other classroom and equipment limitations not readily recognized by the casual observer are: ceiling height; door openings; elevator size; stairwell sizes; compatibility of electricity, air, water, gas; leveling; structural floor weight; special wiring; vibrations; special drains; noise control; air pollution; and government permits (x-ray, nuclear). Although removed from equipment installation charges, certain types of machinery may have additional cost factors, represented by unique freight problems, such as being very fragile, temperature sensitive, or extraordinary in size. The lead time necessary for delivery for specific types of equipment may necessitate putting off implementation of that part of the curriculum. If a project has a very tight time schedule, a consultant might recommend a penalty clause be written into any equipment contract.

In order to get up-to-date information concerning equipment and to involve the faculty, the consultant might recommend interviewing of sales engineers, and visitation of local industries and schools using similar equipment. Preliminary specifications could be written around a model machine that would be defined by function, as opposed to a machine designated by brand name. Involvement at this preliminary level with advisory committees would be desirable. They are able to lend their expertise to the selection of the equipment. Much further down the line, bid documents might be prepared by the consultant with the aid and advice of the faculty, or the consultant may take his recommendations to the school and these in turn would be documented by the faculty for bidding. It may be the function of the consultant to receive and evaluate bids. The advantage would be that he would look at the equipment from an objective point of view; however, he may have his own biases. On the other hand, the faculty might wish to evaluate bids, as they are the ones who will be using the equipment and may be more aware of the types of teaching that they would like to have take place on this equipment.

Facilities

Once the classroom and equipment specifications have taken some general form, a consideration should be given to the facilities that would house these classrooms and equipment. A number of parameters on space requirements would now be encountered. For instance, what is the projected enrollment? What is the philosophy concerning the number of students in a lecture or a laboratory or an audiovisual tutorial system? The consultant might be asked to recommend maximum-minimum class sizes. What are the advantages and disadvantages of large and small sections? It might be argued that in large sections the students learn as well as they do in small sections. Conversely, a small section may enable the teacher to give more personalized attention. Obviously, the cost factor is going to be different in each one of these cases. How many duplicate classrooms should there be? What is the utilization factor for these rooms? How would a consultant arrive at a utilization factor, normal hours of operation, downtime for maintenance? Each school appears to have a different way to calculate utilization factors. The consultant should give the pros and cons of different ways of calculating utilization factors.

The method of teaching will somewhat determine the shape and size of a teaching classroom or laboratory. A number of questions to be answered might be:

1. Should the classroom be contained within the laboratory? Or, should it be adjacent to the laboratory, or, possibly remotely located? Should a tool room be adjacent to the laboratory or contained within? Should laboratories or classrooms fit in with normal student flow?

2. What type of teaching is taking place — a classical approach where a teacher lectures and demonstrates before the class or, possibly a team-teaching approach? Either might have a different effect on classroom spacing.

3. Are there any standards that might apply to particular areas, such as the machine shop area. What are the recommended standards? Outside of the regular building codes, should thought be given to bay sizes?

4. When defining the space, thought must be given to compatibility of equipment and the facilities to house the equipment. Should equipment be housed on the ground floor or upper level? Is there going to be electrical interference generated by high-frequency welding that might interfere with a computer console?

After many of the parameters have been roughed in, the consultant should approach the architect to determine if all of these parameters will fit into a space, be consistent with the design of the campus or the building, and be within cost limitations. The architect might make recommendations relative to reducing the building cost or indicate that the space might be too large for the number of students that it will serve. The consultant would then try to adjust the spacing or the equipment specified to meet the objectives of the curriculum while meeting the necessary parameters of the architect. The architect and consultant should have a very close relationship with the primary duty of the consultant being concerned with the implementation of the curriculum and the primary concern of the architect to house that curriculum within an efficient space. The involvement of the consultant with the school faculty will be fairly well determined by the nature of the contract between the consultant and the school. It is an advantage for the consultant to maintain a good working relationship with the faculty, independent of the consultant's official status.

Staff

After preliminary decisions have been made concerning classrooms, equipment, and facilities, the consultant might be called upon to make recommendations relative to staffing. This staffing includes semiprofessional and professional. The semiprofessional personnel might include maintenance help, audiovisual technicians, laboratory help, and tool room help. A job description for each one of these positions would help determine whether they could be students or would have to be hired from the industrial market. consultant might be asked what the cost of this kind of help would be and where the administration could find that help. Skilled help might be obtained through newspaper ads, trade journal papers, and employment services. Students might be found by teachers within the curriculum or through student placement services.

Professional teachers or administrators for the new curriculum would have their job function defined by the curriculum, teaching methods, and equipment. The consultant may then be asked to determine what the minimum qualifications would be for a person to serve as a teacher or administrator within this curriculum. The consultant might talk in general terms of degrees, experience, personality, and availability in the current market. Specifically, he might approach the pros and cons of hiring education-degree people as opposed to engineering-degree people. Can an engineering degree person teach in a technology related to mechanical engineering? Or could a person with an education degree and some industrial experience better serve in this type of situation? What is available in the market place? Can the school afford what is available? These are questions that need answering by the consultant and the school. Under varying circumstances, the recommendations will be different. Faculty can be obtained, or at least advertised for, through the usual places: journals, placement bureaus, personal contacts, professional societies, state boards of education, and newspaper ads.

If a curriculum involves a changing technology, or needs continual updating of the personnel, the consultant might be called upon to recommend a development program for strengthening the existing staff. In-service training, further academic training, professional meetings, and industrial experience, are a number of possible recommendations. Each one should be approached in the light of a particular school's situation. What are the pros and cons of each one of these development programs for the staff?

Budget and Funding

Although budgeting and money considerations generally fall outside the area of mechanical technology, presidents of colleges always ask, "Where can I get funding?" A consultant should at least be aware of federal, state, and local programs through which funds are available. In addition, foundations and donations may be sought after by the institution. However, this is not his primary concern. The capital budget for the curriculum will be the sum total of all of the preceding items. The cost will be determined by the architect in cooperation with the consultant. Operational expense estimates of the curriculum (cost of staff and supplies) would probably be determined by the faculty and the consultant. These, of course, would be highly dependent upon the type of staff hired and the supplies needed for the curriculum.

Summary

The hypothetical situation where a consultant has gone through the areas of classroom and equipment selection, facilities, staff and budget, without being aware of any limitations, does not exist. The consultant would, in a normal flow of operation, continually adjust each one of the topic areas as the limiting or expanding parameters became known to him. Limitations, in any of these areas may cause corresponding changes in other areas. Some changes may affect only facilities and staffing. In greater depth, they may affect the curriculum and the teaching methods as well. The curriculum and the teaching methods in turn would require a new evaluation of the facilities and staffing problem. The seemingly circular situation does not go on ad infinitum; it eventually approaches a solution. Based upon a continual reevaluation of all of the areas, the consultant would finally make his recommendations.

DISCUSSION BY PARTICIPANTS

When making recommendations for facilities, the consultant should be able to give approximate program costs to the client in terms of original capital investment (both immediate and projected) and operational cost for the future. Further, the consultant should quote costs based upon what it should take to implement a quality program, and not make recommendations based upon a client's immediate financial resources. If necessary, the consultant should be able to say that there is insufficient financial support to start an adequate program when, in his opinion, this is the case.

The consultant should consider recommending, when appropriate, the installation of several technology programs that might share in the initial cost of laboratory equipment and thus bring about a maximum cost effectiveness in the purchase of equipment. Where this is done, it is sometimes feasible to recommend that a shared laboratory facility support a basic core of subjects in mechanical technology.

Another alternative that should be considered by the consultant in recommending new program facilities is the possibility of using local industry facilities for a part of the laboratory instruction. It is sometimes possible to contract for certain laboratory facilities of local industry to be used for

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educational purposes. Frequently, the industry will supply a staff member of their own to assist in the instruction.

In recommending the equipping of a new laboratory facility, consideration should be given to spreading equipment purchase out over two years or the total length of the training program. First-year laboratory equipment may be purchased prior to the opening of the program for use by first-year students, and second-year laboratory equipment may be bought prior to the beginning of the second-year class. This sometimes provides financial relief to the institution by spreading capital outlay for laboratory equipment over several years.

Recruitment of qualified staff is always difficult. The consultant should not necessarily make the tacit assumption that all staff members in a mechanical engineering technology department must be engineers. The staffing pattern must, however, be appropriate to the curriculum content. Many excellent staff members may be available with academic preparation in other related technical fields. In fact, consideration should always be given to qualified staff who may not have baccalaureate degrees.

In staffing recommendations, consideration should always be given to differentiated staffing patterns; that is, the use of laboratory instructors, laboratory and teaching aids, and teaching assistants wherever their services might be appropriate.

SUMMARY

The purpose of this report is to bring to the attention of both the consultant and those who would employ a consultant, certain key factors that should be considered in the consultive exchange related to mechanical engineering technology. These factors have, in the main, related to the detailed areas of technical education which involve (1) planning the curriculum based upon realistic manpower needs, (2) planning for the equipment and the physical facility, and (3) planning for the staff resources needed to implement the program.

While not explicitly covered, but implicit to the entire program development process is the need for a genuine commitment by the institution in question to support the technician training program. This support includes not only financial support, but an abiding philosophical support and commitment to occupational education; a commitment which expresses the fact that the training of students for gainful employment as technicians is of equal importance to any other training activity within the institution.

This kind of program support is a prerequisite to an effective dialog between the consultant and the institution planning and putting into effect a technical curriculum.